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Comments on the Weldon Spring Site Draft (August 2002) Long-Term Stewardship Plan (LTSP):

H-1 The radioactive and explosives wastes at the Weldon Spring Site have been of great concern to me since I first learned about them, in the 1970s. And the more I have learned, the greater have been my concerns. The site certainly looks less complicated now. Instead of 40-plus buildings and structures at the former 226-acre Atomic Energy Commission site, merely one huge 45-acre, seven-stories-high storage bunker (disposal cell) remains. I understand there is not even a fence around the old uranium/thorium nuclear weapons plant site anymore.

The contiguous TNT-DNT ordnance works (comprising most of the 17,233 acres of towns and farmland that were condemned during World War II) also has fewer structures. Some have collapsed over the years; some were dismantled**;** and some were incinerated, along with buried wooden pipelines, coated in part with TNT.

Contaminated soils, raffinates (industrial process sludges), and other debris have been dug up from the uranium plant site**;** buildings were dismantled or blown up**;** things were hosed down, transported, piled up and covered up within the site. I have no idea how many workers, engineers, geologists, and other Department of Energy and US Army employees and contractors have worked at the Weldon Spring Site over the years. The amount of work expended on the cleanup, however, and the risks to which employees have exposed themselves during the cleanup effort are gigantic and heroic. These folks deserve a great deal of appreciation --- even though I don't agree that the site is all cleaned up.

Response H-1: A significant amount of work has been completed at the DOE and contiguous Army sites, as noted in this comment. These activities were conducted in a safe manner in accordance with approved health and safety plans. It is not correct to characterize building demolition activities as "buildings were …blown up". The buildings were decontaminated and dismantled in a very controlled manner to minimize the release of airborne contaminants. The work environment was monitored to ensure the effectiveness of control measures, and to protect the health and safety of workers. While workers faced potential exposure to radioactive, chemical, and industrial hazards during site cleanup activities, these hazards were controlled through engineering design and adherence to accepted health and safety protocols.

I am therefore submitting comments and questions, but also concerns.

Predictions about the Weldon Spring Site's future:

H-2 Hazards remain because some of the consolidated wastes will continue giving off radioactive gases, particles, and rays virtually forever --- literally for billions of years --- and because some of the wastes have leached and blown and otherwise migrated into inaccessible, known and unknown, above- and below-ground and fissures and fractures. Over time, these wastes could become dislodged and resuspended as the groundwater levels fluctuate, eventually finding pathways to the environment.

The DOE has promised the bunker's St. Charles County neighbors that "institutional controls" will keep people and the environment safe from the Weldon Spring hazards --- at least for one thousand years. Can we really rely, however, on predictions about human institutions for as long as a millennium? The US Constitution, outlining our nation's most important institutional controls, was only signed 215 years ago.
Thinking about Weldon Spring's current and future groundwater unknowns, as I have for several decades, I was struck by some comments in a book published in 2000, entitled <u>Prediction – Science, Decision Making, and the Future of Nature</u>. A description of the difficulties of trying to project the future of the proposed Yucca Mountain, Nevada, nuclear waste repository includes the following:

> A key aspect of the modeling effort involves full characterization and prediction of 'percolation flux,' a measure of the amount of water that is likely to seep into the waste holding areas. The higher the percolation flux, the more water that will migrate into areas where the radioactive material is stored, potentially accelerating corrosion of the waste packages and transporting radionuclides from the repository to the accessible environment. (Daniel Sarewitz, et al., editors. Washington, DC: Island Press, p. 351.)

The Weldon Spring wastes are not deep in the ground and are not stored in packages. They are merely piled up inside a big cell. But the need to predict accurately about the percolation and migration of water is similar. And perhaps equally relevant to Weldon Spring and other sites that harbor permanent toxins**:** "The time frame for this modeling exercise is almost <u>extrahistorical</u>**,** on the order of tens of thousands of years**. . . .** Geologic and hydrologic characterizations of the Yucca Mountain site are evolving and have suffered from a paucity of relevant data. In some cases, key model parameters have been established through expert elicitation, with little or no observational data for the purpose of validation." (<u>loc. cit</u>.**,** emphasis added)

Response H-2: Site cleanup activities were conducted in accordance with plans prepared and approved by site oversight agencies including the EPA and Missouri DNR. Cleanup criteria in soil and other impacted environmental media (those for groundwater have yet to be finalized) have been developed consistent with EPA criteria and procedures, and were approved for use at the site by EPA and Missouri DNR. The engineered disposal cell has been designed and constructed to maintain its integrity for 1,000 years or longer. Similar disposal cells have been constructed in other parts of the country to contain similar wastes.

The DOE acknowledges your concern about the longevity of the disposal cell. This is one of the reasons for the LTS Plan (i.e., to develop procedures for addressing any problems with the cell as they may arise in the future). It is not possible to predict with certainty the likelihood for future groundwater contamination. The safety of the nearby community will be maintained through a combination of the remedial actions conducted to date, maintenance of the disposal cell as needed, and continuation of the groundwater monitoring program.

H-3 The draft Long-Term Stewardship Plan for Weldon Spring predicts on page 3-6 that "the transient drainage water production rate will decrease steadily over the next ten years until it becomes insignificant." I find that prediction extremely difficult to understand. Reflecting on the longevity of the radioactive materials versus the 30-year (?) guaranteed life of the high-density polyethylene perforated pipes and geomembranes and other man-made textiles and materials in the cap and base of the cell, I find it hard to believe that the amount of water that will percolate through the disposal cell will decrease as the cell ages. On the contrary, I would expect it to increase.

Response H-3: The water (leachate) that is currently being collected in the leachate collection and recovery system is water that was introduced prior to the cap being installed or was water that was used during the construction process. No new water has been introduced into the cell since the cap was installed. The leachate flow rate has been decreasing as predicted and will continue to do so for the next five to ten years until it reaches a negligible generation rate. The cap was designed to shed water that falls during precipitation events to preclude infiltration. Additionally, the highly compacted clays used in the cap, coupled with the synthetic materials that comprise the cap, would not allow infiltration. In the long term, no significant quantities of leachate are expected to be generated; however, DOE will continue to monitor leachate quality and quantity indefinitely.

H-4 A highly experienced soils engineer gave me a detailed written description several years ago of the use of soils during the construction of the disposal cell that did not conform to the specifications. He also described a lack of sufficient quality control over the compacting of the soils and clays, and other defects in the base of the cell.

Response H-4: The disposal cell was built in accordance with design specifications and approved quality control procedures. Three independent quality assurance groups were utilized during disposal cell construction. If you have information to the contrary, please provide it to us so that we can investigate the significance of such issues. Our goal is to ensure the health and safety of the nearby community, and we appreciate any help individuals can provide in this endeavor.

H-5 I wonder about the rate at which the bentonite mat and peat layer may become saturated with uranium and other constituents from the leachate as it percolates downward. Who will know? Is remediation even possible?

Response H-5: Leachate that percolates through the waste pile is collected in the leachate collection and recovery system. This system is the primary means to control and manage leachate. The bentonite is simply another physical barrier like the clay and HDPE liner and is not intended to reduce the uranium or any other constituent in the leachate. The peat layer was installed to reduce the uranium concentration in the leachate but is not the primary method for managing leachate. No remediation would be required if the peat's reductive capacity became exhausted.

The longevity of the wastes --- and Institutional Controls:

H-6 I have mostly not participated in the discussions and debates about an LTSP for the Weldon Spring wastes because the Environmental Protection Agency's requirements for surveillance and maintenance are so short-lived when compared with the half-lives of Weldon Spring's predominant radioactive contaminants of concern. As summarized in the draft Weldon Spring LTSP, page 1-2:

> 40 CFR 1292, Subpart D**:** "The cell must be designed to remain effective for 1,000 years, or at least 200 years."
>
> 40 CFR 264.117**:** "postclosure care must begin upon disposal cell closure and continue for at least 30 years."

H-6 cont. The hazardous life of a radioactive isotope lasts for approximately ten times its half-life. That is, the isotope will continue releasing radioactive particles and rays for at least ten times its half-life. The following half-lives of isotopes at Weldon Spring far exceed the EPA's Superfund requirements:

uranium-238 = 4.5 billion years.	thorium-230 = 75,400 years
thorium-232 = 14 billion years.	radium-226 = 1,599 years

Response H-6: The DOE and EPA are aware of the long half-lives associated with the radioactive contaminants present at the site. The remedial action approach and disposal cell were designed to address this concern. These long half-lives increase the importance for the LTS Plan, and we appreciate your input to this process. As a note, the hazardous life of many chemical contaminants (such as heavy metals) addressed by EPA's requirements under Superfund is infinite.

H-7 The US Geological Survey, in reports published in the 1980's and 90s, noted the fact that recycled uranium and thorium scrap were also processed at Weldon Spring. (Please see, for example, the USGS Water-Resources Investigations Report 85-4272 by M.J. Kleeschulte and L.F. Emmett, entitled "Compilation and Preliminary Interpretation of Hydrologic Data for Weldon Spring," at pp. 1, 2, and 35). This information was later acknowledged in March 2001 by the DOE, when it published nine site-specific studies, including one about Weldon Spring.

Two of the long-lived isotopes that have been detected at nuclear weapons facilities that processed post-reactor uranium and thorium are:

technetium-99 = 213,000 years.	plutonium-239 = 24,100 years

Although I do not believe I have seen any accounting in DOE reports of the presence of plutonium at Weldon Spring, more than ten years ago several former WS workers told members of the St. Charles Countians Against Hazardous Wastes that plutonium had been on site. (I had always discounted those reports, but I was wrong. As I often say to people, the workers usually know what they're talking about.)

Response H-7: See Response A-7.

H-8 The following EPA definition of the term "institutional controls" appears in the LTSP as a footnote: "non-engineering measures --- usually, but not always, legal controls --- designed to prevent or limit exposure to hazardous substances left in place at a site or to ensure effectiveness of the remedy." (p.2-41)

To assure the St. Charles public that "institutional controls" can be kept in place for the requisite duration of the hazards of the Weldon Spring contaminants seems to me to be inappropriate. No one expects the U.S. government to stay around at Weldon Spring for the entire duration. But one would expect that after the government has spent about a billion dollars on cleanup, it would not leave behind extremely hazardous materials in Weldon Spring's karst terrain, and encourage the public to use the site.

Response H-8: The decision to construct an on-site disposal facility was a consensus developed through the CERCLA process, including public participation. Likewise, the concept of an interpretive center, hike and bike trail, and access to the disposal cell was developed with community involvement and represents a consensus as to how to keep the public informed.

H-9 In addition to the disposal cell, other Weldon Spring sites recognized in the LTSP as requiring long-term institutional controls include the following: (1) twin culverts in [under ?] the County Route D right-of-way within/at the Frog Pond Outlet, one mile west of State Highway 94; (2) a metal pipe culvert under Highway 94 at the Southeast Drainage; (3) soil and sediment along [and no doubt below] the SE Drainage, a losing stream that served as an industrial process outfall sewer for the uranium plant; (4) the Quarry; and (5) the reduction zone area that lies between the quarry and the Femme Osage Slough [where people fish **!** and where the Katy Trail is located] (pages 2-13 and 2-14)**;** and (6) various springs and "areas overlying contaminated ground water plumes." (page 3-3) As the former haul road used for transporting the Quarry's highly radioactive bulk wastes to the Chemical Plant site (p. 2-15), the Hamburg Trail is also no doubt contaminated and should require institutional controls. Other areas of concern include the unnamed tributary of Schote Creek that flows from the former raffinate pit area and Ash Pond (at the Uranium Plant Site), and then into the Busch Conservation Area's Lake 35, Schote Creek, the Dardenne Creek, and on into the Mississippi River.

Response H-9: Off-site areas that have been remediated to unrestricted use conditions and have no attendant health and safety issues do not require LTS oversight. In addition, it should be noted that no highly radioactive waste was located at the WSS. Each haul truck that was used to haul the quarry bulk wastes was monitored with radiation detectors and determined to be clean prior to being allowed onto the haul road. Additionally, the haul road was routinely monitored with radiation detectors to verify that it remained clean. A final radiation survey was conducted at the conclusion of all waste hauling and, again, verified the clean state of the haul road.

Public Access:

H-10 Actually, I believe that all the above sites should be removed from public access in perpetuity. In the meantime, I have to wonder which of these places are currently placarded to warn potential visitors of the risks. I did notice on page 3-22 of the LTSP that the "DOE will place a health advisory at the bottom end of the [disposal cell] ramp, asking the public to consider if the climb to the top of the cell will exceed their physical abilities." What about their immunity to radiation?

Response H-10: The radiation levels on the disposal cell are indistinguishable from background radiation. The risk associated with physical exertion is an issue of concern associated with climbing to the top of the cell.

I must say that writing these comments is not great fun. I'm being very critical about the residual messes at the Weldon Spring Site in spite of the fact that I know how hard and efficiently many, many people have worked toward the goal of cleaning it all up.

H-11 I have never believed that the public should be encouraged or even allowed to visit areas known to contain residual contamination. When I first heard that tourists were to be able to climb on top of the Weldon Spring bunker, I thought it was a joke. I have never understood why the Missouri Department of Conservation has allowed people to fish in Busch Wildlife Lakes 34, 35, and 36. I believe the Southeast Drainage and Burgermeister Spring should somehow be barricaded or cordoned off, or at least be marked with signs indicating that elevated levels of radioactivity may be present.

Response H-11: The radiation levels on the disposal cell are indistinguishable from background radiation, hence, there is no reason to restrict individuals from climbing to the top of this facility. See response J-40 regarding fishing in Busch lakes. Risk assessments for the residual contaminants in the Southeast Drainage and at Burgermeister Spring have demonstrated that recreational exposure poses no incremental risk to the public.

H-12 Between the DOE's anticipated spraying of herbicides on the radioactive waste disposal cell cap (in an effort to protect the radon barrier from penetrating vegetation, and thus the potential emission of radioactive gases and dusts), the cell ramp leading to the top hardly seems to be a friendly environment for the public, particularly for the young and the elderly. (LTSP, p. 3-7)

Response H-12: Use of herbicides will be very minor and localized. The cell rock cover was designed and constructed to resist vegetative pressures.

The Disposal/Storage Cell:

H-13 <> **The contents:** Having asked for many years for an estimate of the amount of radioactivity in the Quarry and in the raffinate pits, and ultimately in the storage cell, I have received various responses with a range of curies (the major unit of measurement used in the U.S. for radioactivity). The estimates have always increased over the years. I was therefore surprised to find the following sentence in the August 2002 draft LTSP**:** "Approximately 1.48 million cubic yards (1.3 million cubic meters) of contaminated waste, with a radioactivity of 4,000 curies are stored in the cell." (p. 2-15**;** see also p. 2-16. Emphasis added.)

The last time I submitted a request to the DOE's Weldon Spring Site seeking the number of curies in the cell (in a letter dated June 30, 2000), I received a copy of a July 24, 2000, letter from the MK-Ferguson Group to DOE Project Manager Steve McCracken, containing the following information**:** the estimated inventories of radionuclide activity in the disposal cell at completion totaled 7,044 curies (538 curies of total uranium**;** 5,617 of thorium-230**;** 678 of thorium-232**;** 157 of radium-226**;** and 54 curies of radiuim-228).

Response H-13: See Response A-7, A-56 and A-93.

H-14 I might add that I was pleased to see the word "stored" in the above 4,000-curie sentence (from page 2-15). I have always understood that the word "disposal" means to get rid of something or at least to remove it from the environment permanently, whereas "storage" refers to a temporary disposition. Because of the predominantly above-ground (91-foot maximum height) design of the cell**;** its rock, clayey soil, and partially-synthetic cap and base**;** and the longevity of its contents, I have always thought of this structure as a storage cell or bunker rather than as a disposal cell.

Response H-14: To avoid any misinterpretation, the word "stored" in the LTS Plan will be changed to "disposed of." The cell is designed as a disposal unit.

H-15 <> **The cap:** The goal described on page 2-15 of trying to protect the disposal cell cap from being penetrated by "plant roots and burrowing animals" deals with a significant concern. While the layers of the cap were designed to total 8.5 feet, it is still conceivable that as invasive plants germinate on the cap, and then grow and die, and as their roots also die and then decay, spaces will remain in the cap that could serve as funnels for the escape of radon gas. Radon gas will of course continue to be generated as long as uranium, thorium and radium progenitors are present --- for an extrahistorical length of time. (The description of a hypothetical biointrusion event appears on pages 3-7 and 3-17.)

The cell and its environs are apparently designed to withstand surface water runoff from a probable, maximum 24-hour storm event. (p. 2-19) What would happen to the rock apron at the toe of a side slope if a more major storm were to occur --- such as a 25-year or 100-year storm? Who would assess the internal and external damage to the cell, and who would direct and pay for the repair, assuming the damage would be repairable?

Response H-15: The issue of biotic damage to the disposal cell cap will be addressed during inspections of the disposal cell. Any significant damage to the integrity of the cell will be repaired as it is discovered., including damage caused by large storms. In addition, it should be noted that the cell has been designed to withstand the Probable Maximum Pricipitation (PMP) event. For this location and climate, the PMP has been determined to be 38.4 inches of rainfall in a 24-hour period. The long-term monitoring includes visual walk-overs of the disposal cell to look for subsidence or other visible damage or changes to the exterior of the cell. It is unclear what type of internal damage you are referring to that would not be manifested though external changes. The DOE has the ultimate responsibility for the disposal cell and would be responsible for funding and directing repairs or modifications that would be necessary.

<> **<u>Gaseous contents:</u>** Remote signaling of alarm conditions is apparently provided for elevated methane
H-16 concentrations. Is there also to be signaling for elevated radon levels? I have never understood why the radon
flux measurements taken outdoors at Weldon Spring have virtually never exceeded background levels during the
many years when the quantities of radon progenitors present have been so high --- such as at the quarry and
H-17 the temporary storage area. What is the likelihood that more precise outdoor radon monitoring equipment will be
developed?

Response H-16: Radon flux measurements document that the cell radon barrier is functioning as designed, i. e., the barrier slows the passage of radon gas to the point where the radon gas produced by the wastes decays to a non-gaseous particulate form within the disposal cell.

There are no provisions for routine radon monitoring associated with the disposal cell.

Response H-17: We cannot foresee what developments may come in the area of radon monitoring. However, the current technology is sufficient for radon monitoring at the Weldon Spring Site.

H-18 It would seem that the potential for settlement-induced cracking of the radon/infiltration barrier would quite probably increase as the cell's cover materials age and disintegrate. I am surprised that the DOE's current stewardship plan specifically says there is <u>not</u> to be postclosure radon monitoring. (p. 3-12) Could this decision be reconsidered, at least to cover the first several five-year postclosure review periods?

Response H-18: Radon measurements taken during construction of the cell cover verified that the radon/infiltration barrier as designed and constructed prevents radon emissions to the air. Also, radon gas does not build up in the cell because its daughter elements quickly decay to non-gaseous elements within the radon/infiltration barrier. As long as the integrity of the cell is maintained, therefore, measuring for radon emission on an annual basis is unnecessary. However, Table 3–6 lists the triggers that would require radon monitoring, which are biointrusion or settlement-induced cracking of the radon/infiltration barrier. The radon/infiltration barrier was installed in a manner to minimize the likelihood for the development of cracks or other defects as the cell ages. The DOE intends to monitor the integrity of the disposal cell cap to address this concern.

H-19 Has any assessment been made to determine if explosive hydrogen and oxygen gas mixtures could build up inside the cell as the result of radiolysis --- that is, the bombardment of radioactive particles and rays on pre-closure, residual water molecules in the cell? Or could radiolysis impact upon water molecules that might enter the cell from rain or snow, particularly as the cell and its cover age? As areas of the cell's bulk wastes differentially collapse or settle, could water collect on the cell's top or side surfaces, resulting in a breakthrough and leakage? (Some people refer to this ponding as "the bathtub effect.") To repeat, could radiation impacts upon water molecules in the cell cause the buildup of potentially explosive hydrogen and oxygen gas mixtures?

Response H-19: This type of assessment would only be applicable to high specific activity materials. Due to the low specific activity of the waste materials in the disposal cell, radiolysis does not present a credible hazard.

Leachate from the Disposal Cell --- and to the Metropolitan St. Louis Sewer District (MSD) :

H-20 The level of concentration of the contaminants in the leachate, after it passes through or perhaps bypasses the adsorbing cell layers, is significant not only as an indication of the cell's performance in containing the wastes (an estimated 2.5 million tons or five billion pounds **!!**), but also because I believe the leachate, at least for the first five-year postclosure period, is being trucked into St. Louis for disposal.

As I understand it, the wastes are to be discharged into the Mississippi River from the MSD Bissell Point Hauled Waste Receiving Station. The draft LTSP does not describe the "treatment," if any, that is to be provided to the leachate and the purge water (from monitoring wells) before they are released to the environment. I only just heard a few weeks ago that these wastes are to be trucked from the Weldon Spring disposal cell to MSD's Bissell Point sewage plant (on East Grand at Highway 70, in the City of St. Louis). The information I have gleaned since then comes from the Draft LTSP at p. 3-12 and from the approval letter MSD sent to the DOE at Weldon Spring on December 2`1, 2001. I would appreciate information about the following:

> **(1)** Is the "treatment" of the leachate and purge water merely the dilution that would result when the wastes enter the river? If so, why are truckloads of liquid waste --- containing a maximum of 15,000 gallons per month, and 15 hundredths of a millicurie **[**thousandths of a curie] per year --- being hauled all the way to the Mississippi River at St. Louis, instead of being discharged into the Mississippi or the Missouri River in St. Charles County, upstream from St. Louis? **(2)** For how many years (or decades, or whatever) do you expect to have a technician available at Weldon Spring to collect and analyze the radioactivity in each of the truckloads prior to shipment? **(3)** Is the leachate to be filtered at Weldon Spring before being monitored and shipped, and if so, where and how is the filtering to be accomplished? **(4)** Or if the filtering is to take place at the Bissell Point Plant, will any resulting Weldon Spring sludge be commingled with other batches of Bissell Point sludge --- for incineration there? (As you know, radioactivity is not destroyed by fire, or by anything else, for that matter. It is either dispersed to the atmosphere or is captured in the ash or filters.

Response H-20: The leachate generated from the WSS disposal facility requires treatment due to the elevated concentration of manganese, a common industrial pollutant. The uranium and other radionuclides concentration (or specific activities) are below those that require treatment prior to discharge.

(1) The Weldon Spring Site has approval to haul up to 15,000 gallons per month of leachate with a total radioactivity of not-to-exceed 0.15 mCi per year. The Metropolitan Sewer District (MSD) is allowed 1 Ci of radioactivity per year in its discharge. MSD allocates this radioactivity limit to its customers who include hospitals, universities, industry, etc. The WSS submitted an application to MSD and received approval to haul the disposal cell leachate to the Bissel Point. (2) The DOE will have the necessary personnel available to support the leachate hauling activities as long as it is required. The WSS is required to collect and analyze samples each time leachate is hauled to MSD. It is anticipated that the leachate flow will decrease over time and that the frequency of the leachate hauling will decrease accordingly. (3) The leachate is pumped directly from the collection sump to the haul truck. No filtering is necessary or required. (4) Our leachate, as well as other leachate and industrial wastewaters from their other customers (i.e., hopsitals, universities, industry, etc.) is commingled. The WSS does not haul any sludge to the MSD facility.

The Groundwater:

"The chemical plant site is on a major surface-water divide that separates the drainage basins in the Missouri and Mississippi rivers," (USGS 93-648, p.3), and "a ground-water divide coincides with the surface-water divide**. . . .**" (Kleeschulte, M.J., and Emmett, L.F.**:** "Compilation and Preliminary Interpretation of Hydrologic Data for the Weldon Spring Radioactive Waste-Disposal Sites --- A Progress Report," 1986, USGS Water-Resources Investigations Report 85-4272**;** p. 29)

That is, some of the groundwater that underlies the site flows toward the Missouri River and some toward the Mississippi. The groundwater is contaminated with trichloroethylene (TCE) and other hazardous solvents and substances, and with radioactive uranium and thorium and their radioactive daughter products. The karst limestone beneath the site no doubt has a five-decade accumulation of uranium and thorium and various hazardous materials, hiding out in crevices, cracks, and fissures below ground.

The groundwater that comes into contact with these dispersed materials becomes radioactive. And as a geologist explained to me recently, "the groundwater may be moving slowly, or it may be moving fast, but it's going to keep moving until it finds a place to get out of the aquifer into a release point --- such as a spring or stream or well." That's where the groundwater comes into the human biosphere**;** that's how living creatures are placed at risk.

H-21 As a non-geologist, I am not able to judge which of the following assessments is correct:

1. "The shallow unconfined bedrock aquifer, which occurs in the Burlington-Keokuk Limestone, is the only aquifer affected by site-related contamination (DOE 2002b) and is therefore of primary interest for ground water monitoring. Localized aquifer properties are controlled by fracture spacing and solution voids in the weathered zone of the formation. Ground water movement is controlled primarily by horizontal bedding planes, fractures, and solution features, resulting in limited downward movement into deeper formations." (Draft Long-Term Stewardship Plan for Weldon Spring, August 2002, p. 2-6**;** emphasis added. The DOE document cited is the "Application for Supplemental Surface Contamination Limits for Southeast Drainage and Frog Pond Drainage Culverts," June 20, 2001.)

2. "The conclusions based on the steady-state model simulation using the pumping scenario indicate 21 percent of the flow in layer 1 [shallow**;** Burlington and Keokuk Limestones**,** and Fern Glen Formation] infiltrates into layer 2 [middle**;** Kimmswick Limestone] in a nine model cell area centered at the chemical plant site. Approximately 80 percent of the flow going out of layer 2 infiltrates into layer 3 [deep**;** St. Peter Sandstone and Potosi Dolomite] in this same area." (Kleeschulte, M.J., and Imes, J.L. "Chronology, Water Quality, and Simulation of Ground-Water Flow at the Weldon Spring Chemical Plant and Vicinity, 1987-90." U.S. Geological Survey Open-File Report 93-648, Feb. 1994, p.98)

I do believe, however, that the statements are contradictory. I also believe that an understanding of the subsurface hydraulic connections is essential for effective groundwater monitoring. It has been reported since the mid-1980s that**:** "Contaminants from the [raffinate] pits have seeped downward through the unconsolidated surficial materials into the underlying bedrock." (Ibid., p. 61)

Response H-21: The two statements are not contradictory. Statement 1 provides a discussion about downward movement on a local scale. Statement 2 provides the estimated percentages of infiltration from one aquifer to the other on a regional scale.

To address the concern about the potential for contaminated water to enter the deep aquifer from directly beneath the chemical plant area, the USGS completed a modeling study to quantitatively assess the groundwater flow system in St. Charles County. A regional three-dimensional groundwater flow model was developed to describe groundwater flow between the shallow, middle, and deep aquifers in the county. The study encompassed 280 square miles, which included most of St. Charles County. The results of the steady state model simulation indicate that 21% of the groundwater flow out of the shallow aquifer beneath the chemical plant area has the potential to enter the middle aquifer. Approximately 80% of the groundwater flow out the middle aquifer in the same area has the potential to infiltrate into the deep aquifer. The quantity of water infiltrating from the shallow aquifer to the deep aquifer is small, and the time required for water to travel this distance is measured in hundreds of years.

Additionally, a water balance analysis of the Burgermeister Spring drainage was performed to evaluate the interaction of the surface water and groundwater systems. A USGS study indicated that about 25% of the total precipitation falling in the Burgermeister Spring drainage leaves as surface water runoff. Using data from this water balance study, information about the groundwater system can be made. On the basis of the three-dimensional groundwater model developed by USGS, 75% of the inflow to the shallow aquifer in the immediate vicinity of the chemical plant area is derived from precipitation. The average total recharge to the shallow aquifer (vertical infiltration and lateral inflow) is about 3.3 in/yr. using the USGS estimate of 2.5 in./yr. for maximum net recharge to the shallow aquifer from precipitation. The vertical recharge to the middle aquifer is 0.7 in./yr. The average total recharge to the middle aquifer (vertical infiltration and lateral inflow) is about 0.75 in./yr. The vertical recharge to the deep aquifer is about 0.6 in./yr.

This analysis likely overestimates the amount of deep infiltration derived from precipitation at the chemical plant area, because the losses from the shallow aquifer to the conduit that discharges at Burgermeister Spring. Comparison of the total flow from Burgermeister Spring to the recharge volume to the aquifer from infiltration of precipitation on the chemical plant and drainage area for Burgermeister Spring indicates that the discharge volume accounts for 80% of the surface infiltration. If 80% of the infiltration were lost to Burgermeister Spring, the net recharge to the shallow aquifer would be 0.5 in./yr. If it were assumed that the remainder of the USGS model behaves as before, the amount of recharge to the deep aquifer would be 0.1 in./yr., which accounts for less than 1% of the total precipitation on the Burgermeister Spring drainage areas.

H-22 In order to reconcile these opposing conclusions --- and to try to understand the extremely complex Weldon Spring groundwater maze better --- I would urge the DOE's Grand Junction Office to enlist the services of the Missouri District Office of the U.S. Geological Survey in Rolla, Missouri. We are fortunate to have a staff of independent, federal, professional geologists located here in our state --- and other USGS scientists <u>who have studied the geology, hydrology, and geochemistry of this site for almost two decades</u>. It was, after all, the USGS scientists who first discovered, in 1986, elevated levels of nitrates (from TNT and DNT production) in groundwater monitoring wells adjacent to the raffinate pits, and thus were able to demonstrate that wastes were indeed seeping out of the pits, and that the pits did not, as assumed, have impermeable clay bases.
Since the Record of Decision (ROD) for the Ground Water Operable Unit has not yet been completed and published, it is difficult to try to formulate meaningful comments about the groundwater stewardship plans. According to the Draft LTSP, for example, at p.3-11, "remedy compliance monitoring will commence" when the ROD is approved, and additional monitoring requirements may be required. I hope the DOE will choose to enlist the USGS in the development of the groundwater ROD. I believe their participation would increase the ROD's validity and credibility.

Response H-22: The USGS has had an active role and been a valuable resource at the WSS during the remedial investigation and site characterization phases of the project. USGS has also provided various other monitoring support during the site remediation, disposal cell construction and waste placement. The scope of the support provided by the USGS has been completed. If a need arises in the future where the USGS's expertise is advantageous, then the DOE would consider enlisting their support.

H-23 The Weldon Spring disposal cell is located in a karst terrain, in a rapidly growing county, upstream and upwind from Missouri's primary population center. The wastes will be dangerous forever. We therefore need to know about the possible movement of contaminated water into geologic formations beneath the shallow aquifer --- throughout the entire Weldon Spring Site. And about the risks involved in deciding whether or not to treat groundwater known to contain radioactive contaminants.

Response H-23: These issues were considered in the decisions that have been developed to date for site cleanup, and will be incorporated into decisions on management of contaminated groundwater at the Chemical Plant Area.

Monitoring of the Groundwater and the Disposal Cell:

H-24 Aside from one groundwater/disposal cell detection monitoring well that was installed south of the cell (MW-2055, at the location of the former MW-2048), the other six monitoring wells designed to detect cell leakage are all located north of the cell, including SP-6301 at Burgermeister Spring in the Busch Memorial Conservation Area. (LTSP, pp. 2-43 and 3-8) Is the one upgradient monitor needed, and if so, why is there only one? And does a contingency plan exist if that one monitor fails?

Response H-24: The one upgradient monitoring well is intended to provide groundwater information upgradient of the disposal cell. In the event of a change of the characteristics in the downgradient monitoring wells, the upgradient well would provide information regarding whether the change was due to the disposal facility or a natural change or one unrelated to the disposal facility.

H-25 When reading about the disposal cell's Leachate Collection and Removal System (LCRS), I keep wondering about the fact that surveillance and maintenance of the system will be needed for hundreds and thousands of years, and beyond. What federal agency can we rely on that will make certain that the monitoring well adjacent to the LCRS sump manhole (under the seven-stories-high disposal cell) continues to function as designed? Who will decide how often a person will be needed to enter the manhole and access the plastic sump storage pipe? What happens when the collection and storage pipes become clogged? What happens when they become embrittled, from aging and radiation exposure? Who will decide when they need to be replaced? Can they be replaced? Who will determine when the valve that controls the dumping of the secondary leachate needs to be repaired or replaced? What is its guaranteed life, and can it be replaced?

Response H-25: The DOE has the responsibility for the long-term monitoring and maintenance of the disposal facility. Leachate flow rate as well as other parameters will be monitored over the long-term. Entry into the LCRS will be done, as necessary, to perform preventative maintenance, inspections or in response to a mechanical problem. Radiation exposure from the low levels of radioactivity in the leachate has no effect on the LCRS storage pipe and if the pipe became compromised, corrective actions would be required. The secondary leachate collection system will require preventative maintenance as recommended by the manufacturer. In the distant future, if the LCRS high density polyethylene (HPDE) piping fails, the disposal cell still has a redundant drainage system comprised of rock surrounding the piping which will continue to provide a drainage path for leachate to exit the disposal cell.

H-26 Regarding the perpetual monitoring of the cell contents and the myriad flow rates and directions of the leachate**:** who is to make certain, over the millennia, that qualified employees are hired and trained to read, interpret and assess the LCRS electronic data that are displayed in the monitoring cabinet in the Train 3 Building? How often are the data to be collected and analyzed? Who will calibrate the monitoring equipment and repair it if necessary? And who will pay for all that, year in and year out, century in and century out?

Response H-26: The DOE is responsible for ensuring that qualified personnel are conducting the monitoring and maintenance activities at the WSS. The data collection frequency for the LCRS will generally be driven by the rate that leachate is generated. Currently, the leachate generation rate is such that, at least, weekly monitoring is required. Over time the leachate flow rate will decrease and less frequent LCRS monitoring will be required. It would be inappropriate at this time to state precisely the monitoring frequency for the long term. Instrument calibration and maintenance will be conducted in accordance with the manufacturer recommendations. It should be noted that the system is designed to be passive in nature, i.e. the cell is built above grade so that the leachate will flow by gravity to the collection sump. Missouri DNR was the principle advocate for this passive system. At essence the LCRS is quite simple and was built this way in order to minimize long term maintenance issues.

H-27 Just for the record, I would like to repeat something I have said for a long time**:** I do not believe that today's monitoring equipment is able to detect with precision and accuracy the radioactive **thorium** that most probably is present in the ground- and surface-waters and in the soil at Weldon Spring. The inability to detect it at this time does not mean it is not present. Thorium is of particular significance because it is not only a serious radioactive toxin, but it is poisonous, as well.

Response H-27: The current analytical techniques are adequate to determine the presence of thorium. The techniques used to analyze thorium have been reviewed and scrutinized several times including by a Missouri DNR funded study. As you may recall, you were on the committee that selected the qualified analytical experts that reviewed this issue. The findings of the study indicated that the techniques employed are more than adequate to detect and quantify thorium at the WSS.

Some monitoring results that I believe demonstrate the need to remediate the groundwater :

In commenting on the groundwater contamination at Weldon Spring, I would like to begin with a paragraph I submitted to the Weldon Spring Site project office three years ago, as a part of my comments on the Weldon Spring groundwater "remedial action plan" (DOE/OR/21548-733) --- which was then, as now, not to try to remove the radioactive wastes.

> Probably it was about ten years ago when a geologist responded to some of my concerns about the Weldon Spring contaminate by saying**:** 'The one thing you really have to worry about is that the Department of Energy not be allowed to walk away from the site without cleaning up the groundwater to concentrations consistent with natural background.' At the time I considered such a possibility to be preposterous.

A question often debated by regulators is "how clean is clean?" --- or how clean should things have to be? As a start, in order to assess whether the Weldon Spring groundwater is unacceptably contaminated or not, I guess we should first decide how much uranium the groundwater would have contained naturally if the US Army would not have built and operated its explosives plant during World War II at Weldon Spring, and if the US Atomic Energy Commission would not have operated its Uranium Feed Materials Plant there (from about 1956 till about 1966). I will address just the radioactive parameters of the natural background.

H-28 Up until the recent past when MK-Ferguson Company, as Project Management Contractor, has described Weldon Spring's background groundwater uranium in its reports (as recently as in the 1999 annual environmental report, for example), it used the figure **2.9 picocuries** per liter (DOE/OR/21548-845**;** page 125 fn.). Argonne National Laboratory, on the other hand, reported in July 1997 that background groundwater uranium in the weathered (overburden) areas is **0.93 picocuries** per liter, and in the unweathered (deep) areas it was **0.48 picocuries** per liter. ("Remedial Investigation for the Groundwater Operable Units at the Chemical Plant Area and the Ordnance Works Area, Weldon Spring," DOE/OR/21548-571, Figures 4.1 and 4.2). Which experts should a person believe?

Response H-28: The values reported in the 1999 ASER were earlier regionally established values used for background at the chemical plant. These values were updated in the 2000 ASER to reflect those developed locally and reported in the Remedial Investigation for the Groundwater Operable Units at the Chemical Plant and Ordnance Works Areas.

H-29 Sometimes the groundwater monitoring data are compared to the EPA's drinking water concentrations as the basis for demonstrating what is permissible, even though no drinking water wells are currently in place within the former Chemical Plant Site. The EPA's new "maximum contaminant level " for uranium --- 20 picocuries, or 30 micrograms, per liter) is to take effect December 8, 2003. ("Weldon Spring Site Environmental Report for Calendar Year 2002," May 2002**;** Table 7-1 fn.) Please note that "permissible" is not synonymous with "safe."

Response H-29: The EPA is the federal agency charged with the responsibility for determining Maximum Contaminant Levels (MCLs) for various contaminants (including radionuclides) in public drinking water systems. These MCLs are identified in 40 CFR 141. As noted in this comment, the promulgated MCL for uranium is to take effect on December 8, 2003. This MCL for uranium is used in a number of documents to provide a point of comparison, with the intent of giving additional perspective on the measured concentrations. The DOE is not endorsing nor criticizing the process used by EPA to determine these values. Any concerns associated with the process used by EPA to determine MCLs, i.e., what is considered to be a "safe" value, should be directed to EPA.

So how does the Weldon Spring groundwater stack up?

H-30 The monitoring data generated over the past two decades are voluminous, and trying to follow the quarterly and annual reports is difficult. But the following recent data give some indication of the fact that radioactive contamination in the groundwater is indeed present in measurable quantities, and at levels that are at times above the permissible standards. These data come from the Missouri Department of Natural Resources unless attributed to the US Department of Energy (DOE).

Year 2002, Quarter One --- Monitoring Well (MW) 1008, south of the quarry**:** 2800 micrograms (perhaps about 930 pCi/L) uranium. The DOE reported in its 2001 annual environmental report that this well yielded a maximum at 4,180 pCi/L of uranium. (page 138)

Year 2002, Quarter One --- 39.6 pCi/L of technetium-99 was measured in MW-3030, a new well located where Raffinate Pit #4 used to be. Zero technetium-99 would have existed in nature. Tc-99 is a fission product, and thus is evidence of the processing of post-reactor uranium at Weldon Spring. "Recent [uranium] data show concentrations above [maximum contaminant levels] MCL" in MW-3030, according to the DOE's "Environmental Monitoring Plan," Revision 9, December 2001, page 3. In the DOE's 2001 annual environmental report, uranium averaged 52**.**92 in MW-3030 samples.

Year 2001, Quarter One --- Spring Well 6303, west of Burgermeister Spring**:** gross alpha was 690 pCi/L. Gross beta was 380 pCi/L. (A footnote indicates the well water had "heavy turbidity" when sampled.)

Year 2001**:** MW-3024 (east of the former Pit 3) yielded a uranium average of 59**.** 82 pCi/L. (DOE's 2001 annual environmental report, page 79) To quote from the DOE's 1999 annual report**:** "This monitoring well was damaged in early 1997 and restoration included drilling out the casing and screen to facilitate installation of new well construction materials**. . . .** Further repairs to this well are anticipated in 2000 to ensure that the seal above the well screen is properly set." (p. 124)

Year 2000, Quarter Two --- 71 pCi/L of gross alpha was measured at Spring Well 5304, at the Lower Southeast Drainage.

Response H-30: While the maximum value of 4180 pCi/l was reported for the monitoring period extending from April 2000 through April 2002, greater concentrations of uranium (6732 pCi/l in 1990) have been reported for this location. Since source removal at the quarry, uranium concentrations at this location have continued to show an overall downward trend. This trend is expected to continue.

The Missouri DNR Quarterly Oversite Report (4th Quarter 2001) states that the Missouri DNR laboratory did not provide sufficient quality control and quality assurance data necessary to validate the values that they reported,therefore, the Technitium-99 data cannot be reviewed for errors or alpha interferences. Detectable alpha concentrations in Technitium-99, a beta emitting radionuclide, would indicate inefficient chemical separation techniques by the laboratory and the data would be rejected if the alpha counts were significant. In the past, Missouri DNR has reviewed and corrected Technetium-99 data due to laboratory errors. Detectable concentrations of Technitium-99 have been re-reported by the Missouri DNR at much lower concentrations based upon a review of the laboratories techniques, which were evaluated and found to have significant alpha contamination. It is not uncommon using standard laboratory processes, techniques, and algorithms, to quantify radionuclides at detectable levels that may not actually be present. As a point of reference, the DOE derived concentration guideline (DCG) for Technitium-99 is 100,000 pCi/l and 4000 pCi/l would be required to exceed EPA gross beta standards relating to drinking water.

Heavy turbidity has a significant impact on the gross alpha and gross beta analyses. Solids in the sample cause the detection limits, errors and the final concentration to be higher than that of low turbidity water. Water produced at the spring is normally clear and has a low flow rate or no flow at all. Sampling techniques may have introduced solids into the sample container which may not be representative of water being discharged from the spring.

We recognize that uranium values from monitoring activities prior to reinstalling MW-3024 were markedly lower. We believe that the upper seal for the reinstalled MW-3024 may be allowing minor leakage from the upper weathered unit giving the perception that the lower unweathered unit is impacted. The vast amount of monitoring data from the surrounding wells demonstrates that the lower unweathered unit is not contaminated..

The gross alpha value reported, 71 pCi/l, is not unusual given the uranium concentrations at this location. Uranium concentrations have ranged between 31 pCi/l and 109 pCi/l for the last two years.

The Quarry and the Femme Osage Slough:

H-31 Quoting from the Draft LTSP**:** Quarry "bulk waste removal was not intended to constitute the final remedy for this area**. . . .** DOE will retain ownership of the quarry property to ensure that positive surface drainage is maintained to prevent ponding and to prevent potential mobilization of residual contaminants in bedrock fractures." (p. 2-41, emphasis added) "Femme Osage Slough is directly south of the quarry and is known to receive contaminated ground water from the quarry through subsurface recharge. There is no natural surface flow from the slough." (p. 2-39) I remember seeing the Missouri River's flood waters extend all the way to the Quarry wall (and no doubt beyond) back in 1993**;** the Femme Osage Slough and its contaminated sediments were totally under water. Is that not "natural surface flow"?

Response H-31: The slough is not a stream but rather a stagnant body similar to a lake, therefore there is no natural flow due to a gradient. Water into and out of the slough is controlled by a valve connecting it to the Missouri River. The 500-year flood referenced in the comment was a catastrophic event and not representative of typical flow.

H-32 I have never understood it when the DOE and its contractors sought to explain why even though the Quarry has had high concentrations of uranium, gross alpha and beta radioactivity, etc., the monitors of the groundwater that flows from the Quarry into the St. Charles County drinking water well-field detect no elevated levels of radioactive materials. I was surprised, therefore, to notice in the second figure in the Draft LTSP's Appendix B that the groundwater to the north of the Femme Osage Slough, and also extending south of the slough, is marked as "Ground Water-Use Restriction." (p. B-3). Although the locations of specific St. Charles County drinking-water production wells are not indicated in Figure B-2, is it possible that the area where groundwater use is to be restricted may include Production Wells 2, 3 and/or 5? If not, why not? That is, to what extent is the boundary line that encircles the restricted area based on hard geochemical and hydrologic data? (The locations of the drinking-water wells are in the 2001 annual environmental report, Figure 7-4, at page 94.) For how many years has the DOE recognized the need to "establish institutional controls to prohibit use of contaminated ground water for irrigation, consumption, or as a surface water source" and "to prevent disturbance of the uranium reduction zone south of the Quarry"? (Draft LTSP, p. 2-41) Why have those controls not been put in place sooner?

Response H-32: Groundwater monitoring locations between the Quarry and the slough have shown uranium contamination and this data has been publicly available for over 15 years. The area indicated of Figure B-2 extends 2,000 ft from the edge of the uranium plume as depicted by the 20 pCi/l isoconcentration contour. None of the production wells are located within this groundwater use restriction boundary. This buffer delineates an area where groundwater extraction should not be performed due to the possibility of intercepting the groundwater plume in the area of influence of a large production well. This will prevent possible mobilization of impacted groundwater into the well field area. The boundary was established on hydraulic behavior of the wells north and south of the slough as influenced by the production wells. PW-8 is located approximately 2,000 ft from the edge of the slough and has shown no hydraulic influence on the wells north of the slough; therefore, this distance was selected as a buffer zone.

Implementation of institutional controls for the quarry groundwater was recognized in the Record of Decision, which was approved in September 1998. Inclusion of the reduction zone was included this year based on the results of the geochemical characterization, which was completed at the end of 2001.

DOE's continued presence at the Weldon Spring Site has provided sufficient controls to prevent groundwater use and ground disturbance in these areas. Due to DOE's relationship with the MDC and St. Charles County, open communication regarding land use is discussed with DOE during the developmental stages. This has afforded DOE the time to evaluate the appropriate institutional controls that will be required to ensure that these areas are not used inappropriately once the DOE is not present at the Weldon Spring site full time.

H-33 And reflecting further on the "uranium reduction zone" that lies south of the Quarry, can anyone explain why the reduction zone would suddenly stop, if indeed it does, at the northern edge of St. Charles County's drinking water wellfield? What is the estimated number of curies of uranium and related radioactive materials that were removed from the contaminated Quarry groundwater and became bound onto the clay in the shale (or whatever) within the low-oxygen, organic-rich reduction zone over the past four decades? That is, how much uranium and thorium (and their daughters) have been entrapped by the soil north and perhaps south of the slough, and beneath it? What are the average volume and flow rate of the water that enters the quarry, percolates through the contaminated, fractured quarry floor and walls, and then travels to the reduction zone --- and stops there?

Response H-33: The zone of reducing conditions at the quarry starts approximately midway between the Katy Trail and the slough and does extend south of the slough. The extent has been determined from oxidation/reduction potential (Eh) measurements in groundwater monitoring wells. Oxidizing conditions are more prevalent in the "well field" portion of the Missouri River alluvium due to the influence of the Missouri River. Recharge to the Missouri River alluvium comes primarily from infiltration of river water, which is oxidized.

Although the reduction zone extends south of the Femme Osage slough, the greatest impact is observed at the location where geochemical conditions change (oxidizing to reducing), which is located north of the Femme Osage slough.

The total mass of uranium in the alluvial materials and limestone bedrock in the shallow aquifer was 1,518 kg. The mass of uranium was calculated by using the uranium distribution in groundwater and equilibrium partitioning coefficients measured prior to the start of the Quarry Interceptor Trench Field Study (2000). This does not account for the approximately 1,200 kg of uranium removed during the remediation of Vicinity Property 9, which is located in the same area.

A groundwater flow volume estimation was presented in the Remedial Investigation for the Quarry Residuals Operable Unit (February 1998). The result of the calculation shows that the volumetric flow of groundwater from the quarry is approximately 7,500 gal/day. The reduction zone does not stop groundwater. Dissolved uranium in groundwater is precipitated at a distinct contact separating soils with characteristics indicative of oxidized conditions from those indicating reducing conditions. Evidence of rapid precipitation of uranium from groundwater has been observed in soil samples that indicated a thin zone exhibiting elevated concentrations of uranium immediately below the contact.

H-34 Should the reduction zone soil not be exhumed?

Response H-34: It would not be prudent to excavate the reduction zone soil. The soil conditions themselves help perpetuate the reducing environment, which in turn attenuates uranium. The clayey soil in this area has abundant organic material in the form of roots, twigs, wood chips, leaves, grass stalks, and carbonaceous sand-size particles, as well as lignitic clays and lignite. Also, it should be remembered that the surface contamination associated with VP-9 was remediated (excavation depths up to 5 ft). Elevated uranium in soils that remain is subsurface and is inaccessible to a recreational land user.

A conclusion:

For sixty years the federal government has been generating great quantities of radioactive waste as the byproducts of producing nuclear weapons. We have been contaminating rivers, lakes, groundwater, air, and soil, and people and other living things in locations throughout the nation. My hope is that America's leaders will recognize that the cleanup of the nuclear weapons messes --- including the remaining wastes at Weldon Spring --- should be accomplished before more messes are created.

With great appreciation for a job well-done, and almost complete. Sincerely, Kay Drey